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Banking and Deposit Insurance as a Risk-Transfer Mechanism

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BANKING AND DEPOSIT INSURANCE AS A RISK-TRANSFER MECHANISM

ABSTRACT

This paper models an economy in which risk-averse savers and risk-neutral entrepreneurs make investment decisions. Aggregate investment in high-yielding risky projects is maximized when risk-neutral agents bear all nondiversifiable risks. A role of banks is to assume nondiversifiable risks by pledging their capital in addition to diversifying risks. Banks, however, do not completely eliminate risks when monitoring by depositors is not perfect. Government deposit insurance that uses tax revenue to pay off depositors effectively remaining risks to entrepreneurs. Deposit insurance improves welfare because imperfect monitoring by the government results in income transfer among risk-neutral agents rather than lower production.

KEYWORDS: Role of Banks; Deposit Insurance; Risk Transfer

JEL CLASSIFICATION: G21

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1. Introduction

The banking business in a traditional sense may be characterized by risky lending, deposit contracts offering fixed terms, implicit or explicit deposit insurance provided by the government, and relatively tight government regulation. This paper shows that these banking arrangements help to increase aggregate investment by effectively transferring nondiversifiable risks from risk-averse savers to risk-neutral entrepreneurs and bankers.

A traditional belief is that the value of banking derives from cost efficiency in financial intermediation. Kindleberger (1984, p.45) lists three aspects of financial intermediation: borrowing at retail and lending at wholesale, lending long and borrowing short, and diversification of risks. He states, "Market making, credit stretching, and risk minimization are threads that run throughout financial history." Traditionally, banks carried out these functions at relatively low costs.

Recent studies emphasize the banks' ability to resolve information problems. Bryant (1980), Diamond and Dybvig (1983), and Jacklin (1987) show that demand deposit contracts enable individuals effectively to share uninsurable liquidity risk. According to them, liquidity needs of individuals are unobservable to the market and, hence, cannot be insured in a normal manner. While these studies focus on information on depositors, some other studies emphasize information on borrowers [e.g., Chan (1983), Diamond (1984), Ramakrishnan and Thakor (1984), and Boyd and Prescott (1986)]. They argue that financial intermediation reduces monitoring costs arising from information asymmetry between borrowers and lenders. Information on bankers has also been considered. Calomiris and Kahn (1991) rationalize demandable debt, a key feature of traditional banking, as a means to discipline bankers when information is incomplete.

These arguments apply to financial intermediaries in general, rather than banks in particular. Increasing sophistication of financial markets has reduced the costs of both transaction services and information production. As a result, there are many financial instruments that can substitute for bank deposits and loans.[1] For example, money market mutual fund shares offer transaction services and liquidity. Stock and bond mutual funds channel savers' money to investment projects and diversify risks at low costs. Established corporations, which are subject to less information asymmetry in general, often reduce their reliance on bank loans by issuing commercial paper. These developments pose questions about the uniqueness of banks and the needs for government intervention, including deposit insurance. For example, if some run-free financial instruments such as money market shares can provide liquidity and payment services as efficiently as banks, deposit insurance as a mechanism to prevent bank runs is not justified.

Gorton and Pennacchi (1990) suggest the creation of a riskless transactions medium as a rationale for banks and deposit insurance. According to them, the creation of riskless securities prevents agents with superior information from taking advantage of uninformed "liquidity traders." This argument does not consider the banks' role of lending to risky borrowers. Thus, they recognize that the same role can be performed by money market mutual funds holding risk-free securities such as Treasury bills.

This paper focuses on the allocation of nondiversifiable risks.

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[1]Haubrich and King (1990) show that demand deposits uniquely contribute as insurance against private contingencies only when other markets are restricted. Calomiris and Kahn (1991) also question the necessity of demand deposits as a monitoring mechanism in modern financial markets.

Apparently, some risks cannot be diversified and hence, must be born by someone.[2] A main assumption is that savers are more risk averse than entrepreneurs and bankers.[3] In this case, it is desirable to have entrepreneurs and bankers bear all nondiversifiable risks. This paper shows that bank deposits are superior to other financial instruments in channelling funds and transferring nondiversifiable risks from risk-averse savers to risk-neutral agents.

In addition to diversifying risks, banks assume nondiversifiable risks by pledging their capital. Since they can increase expected profits by holding risky portfolios, banks will not completely eliminate risks when monitoring is less than perfect. The government eliminates risks for depositors by providing deposit insurance and regulating banks. In the event that banks fail due to incomplete monitoring, the government taxes entrepreneurs to pay off depositors. Deposit insurance, thus, effectively transfers risks from depositors to entrepreneurs. The transfer of nondiversifiable risks results in a lower equilibrium interest rate and a higher level of investment. The utility gains of savers and entrepreneurs from increased investment depend on assumptions about investment opportunities and market structure. *Ex post* redistribution through taxation, however, unambiguously improves the *ex ante* utility of both savers and entrepreneurs because aggregate production is higher with deposit insurance. While inability of depositors to monitor banks lowers the level of production, ineffective monitoring by banking authorities simply distorts the distribution of income. Thus, deposit insurance can still improve welfare even if the

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[2]Greenspan (1993) states, "Risk can be priced properly. But all risk cannot be eliminated. Even more important, the willingness to take risk is essential to the growth of the macroeconomy."

[3]Kindleberger (1984, p.45) notes that financial intermediaries stand between risky borrowers and risk-averse lenders.

government is less effective than depositors in monitoring banks.

The next section models an economy in which savers and entrepreneurs maximize their utility and shows the roles of banks and deposit insurance. Conclusions follow the model.

2. The Model

This section analyzes the maximizing behavior of individuals with different attitudes toward risk to show the effects of risk allocation on social welfare. The analysis focuses on the roles of banks and government-backed deposit insurance in reducing risks for depositors. The model shows that demand deposit contracts insured by the government are an effective mechanism of transferring nondiversifiable risks from risk-averse savers to risk-neutral agents. The transfer of nondiversifiable risks increases investment and, hence, expected production.

2.a. The structure of the economy

Individuals in this economy live two periods. No one dies early because this model does not consider the liquidity need of individuals, which has been well addressed by Bryant (1980) and Diamond and Dybvig (1983). Individuals are classified into two types, savers and entrepreneurs. Savers are risk averse, and entrepreneurs are risk neutral.

$$U_s'(C) > 0, \quad U_s''(C) < 0$$

$$U_e'(C) > 0, \quad U_e''(C) = 0$$

where C denotes consumption, and subscripts s and c stand for savers and entrepreneurs.

Everybody is endowed with one unit of good and concerned only about consumption in the second period. Goods can be either stored or invested in production. While self-storage is available to everybody, only entrepreneurs have access to production technology. Any fraction of the good can be stored, but investment is lumpy. Each production project requires X (X > 1) units of investment. If an entrepreneur fails to attract enough capital (X - 1) from savers, he/she has to rely on self-storage. Goods are identical for the consumption purpose but different for the investment purpose. While goods owned by savers can be used in all production projects, goods owned by entrepreneurs are project-specific. Thus, entrepreneurs cannot invest in each other's projects.[4] A rationale for this assumption may be that fixed investment was already made in previous periods or that entrepreneurs own human capital. There are large numbers of savers (n) and entrepreneurs (m). Thus, the capital market is competitive.

The return on self-storage is 1 per unit with certainty. On the other hand, production offers an expected return greater than or equal to 1, but it is risky. Production can fail, and the failure probability depends on the state of the economy. There are two possible states of the economy, good and bad. If the good state occurs, the failure probability is zero. In the bad state, a proportion, P_f, of investment projects fails, and each project is equally likely to fail. Thus, P_f is the probability that an investment project fails in the bad state. In this situation, investing in a large number of projects will diversify the failure risk of individual projects. The risk of the bad state of the economy, however, cannot be diversified.

The return from failed production is zero, and the return from succeeded production varies across projects. The return from the j^{th} project conditional upon success:

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[4]This assumption does not affect qualitative results as long as the goods owned by entrepreneurs are not enough to utilize all profitable production opportunities.

$$R_j = f(j) \qquad \text{where} \quad j = 1, ---, m$$

$$\Delta f/\Delta j < 0$$

Production projects are indexed based on profitability, starting from the most profitable project. The return decreases because of differing abilities or opportunities of entrepreneurs. The expected return from the m^{th} project:

$$E_m(R) = P_b \cdot \{P_f \cdot 0 + (1-P_f) \cdot R_m\} + (1-P_b) \cdot R_m = (1 - P_b \cdot P_f) \cdot R_m = 1 \qquad \text{(A1)}$$

where P_b = the probability that the bad state occurs

P_f = the probability of bank failure in the bad state.

Thus, the m^{th} entrepreneur is indifferent between self-storage and production, and all other entrepreneurs desire to undertake production projects.

In aggregate, there is balance between available resources and production opportunities.

$$n + m = m \cdot X \qquad \text{(A2)}$$

Thus, production opportunities are exhausted when everybody fully invests in production.

2.b. Utility Maximization

Individuals make portfolio decisions in the first period to maximize the expected utility from second-period consumption. The decisions of entrepreneurs, who are risk neutral, are simple. They undertake production projects if the expected return on their investment after paying off savers is greater than or equal to 1, which is the opportunity cost of capital. The decision of the j^{th} entrepreneur is to undertake the production project if

$$E(R) = P_b \cdot [P_f \cdot 0 + (1-P_f) \cdot \{R_j \cdot X - R^E \cdot (X-1)\}] + (1-P_b) \cdot \{R_j \cdot X - R^E \cdot (X-1)\}$$
$$= (1 - P_b \cdot P_f) \cdot \{R_j \cdot X - R^E \cdot (X - 1)\} \geq 1 \qquad \text{(E1)}$$

where R^E is the equilibrium return promised to savers.

In this economy, lenders do not need to monitor borrowers because borrowers selfselect given the equilibrium borrowing cost. This simple structure is adopted to narrow the focus of the paper.

Savers maximize the expected utility by choosing the optimum proportion of their endowments to be invested in production. Assuming for a moment that each individual lends to only one entrepreneur because of high transaction costs, the expected utility of savers:

$$E(U_s) = P_b \cdot [P_f \cdot U(1-\theta) + (1 - P_f) \cdot U\{(1-\theta)+\theta \cdot R^E\}] + (1 - P_b) \cdot U\{(1-\theta)+\theta \cdot R^E\}$$

$$= P_b \cdot P_f \cdot U(1-\theta) + (1 - P_b \cdot P_f) \cdot U\{(1-\theta)+\theta \cdot R^E\} \qquad \text{(E2)}$$

where θ is the proportion of endowments invested in production.

Since the capital market is competitive, individuals take R^E as given.

$$\partial E(U_s)/\partial\theta = P_b \cdot P_f \cdot \{\partial U(C_L)/\partial C_L\} \cdot (-1) + (1-P_b \cdot P_f) \cdot \{\partial U(C_H)/\partial C_H\} \cdot (R^E-1)$$

where $C_L = (1 - \theta)$, the amount of consumption when the low portfolio return is realized.

C_H - $\{(1-\theta)+\theta \cdot R^E\}$, the amount of consumption when the high portfolio return is realized.

$$\partial^2 E(U_s)/\partial\theta^2 = P_b \cdot P_f \cdot \{\partial^2 U(C_L)/\partial C_L^2\} \cdot (\partial C_L/\partial\theta)^2 + P_b \cdot P_f \cdot \{\partial U(C_L)/\partial C_L\} \cdot (\partial^2 C_L/\partial\theta^2)$$

$$+ (1-P_b \cdot P_f) \cdot \{\partial^2 U(C_H)/\partial C_H^2\} \cdot (\partial C_H/\partial\theta)^2$$

$$+ (1-P_b \cdot P_f) \cdot \{\partial U(C_H)/\partial C_H\} \cdot (\partial^2 C_H/\partial\theta^2)$$

$$= P_b \cdot P_f \cdot \{\partial^2 U(C_L)/\partial C_L^2\} + (1-P_b \cdot P_f) \cdot \{\partial^2 U(C_H)/\partial C_H^2\} \cdot (R^E-1)^2 \leq 0$$

since $\partial^2 U_s/\partial C^2 < 0$.

Thus, the marginal gain from shifting endowments from self-storage to investment in production decreases as the portfolio share of investment increases. An intuitive explanation for this result is as follows. A shift of endowments from self-storage to investment results in an increase in C_H and a decrease in C_L at constant rates. Accordingly, the expected return on the portfolio increases at a constant rate, and the gap between C_L and C_H increases with the portfolio share of investment. When the portfolio share of investment is high, therefore, additional investment in production involves a sacrifice of stored goods in a region where marginal utility is high and a gain from investment in a region where marginal utility is low. Thus, the attractiveness of marginal investment decreases with the portfolio share of investment.

This result suggests that there may exist an interior solution, i.e., $\partial E(U_s)/\partial\theta = 0$ at θ^* that is greater than zero but less than one. The optimum proportion θ^* cannot be one in this case because the expected return from the marginal project when $\theta = 1$ is one per unit (by A1 and A2), which is not acceptable to risk-averse savers. Thus, an interior solution is guaranteed if $\partial E(U_s)/\partial\theta > 0$ when $\theta = 0$ and $R^E = R_1{}^0$, where $R_1{}^0$ is the return that satisfies the zero profit condition for the most productive entrepreneur. In other words, the return from the most profitable production project is high enough to induce risk-averse savers to invest some of their endowments in the project. This condition will be assumed to be satisfied throughout the remainder of this paper.

2.c. Equilibrium return on saving

The aggregate supply of funds is equal to the aggregate demand at the equilibrium return, R^E. The aggregate supply is the optimum proportion of savers' endowments invested in production multiplied by the number of savers $\{n\cdot\theta^*(R^E)\}$. The proportion θ is an increasing function of R^E because $\partial E(U_s)/\partial\theta$ is higher at every level of θ when R^E is higher.

$$\{\partial E(U_s)/\partial\theta\}/\partial R^E = (1-P_b\cdot P_f)\cdot\{\partial U(C_H)/\partial C_H\} > 0$$

The aggregate demand for funds is the required borrowing per project multiplied by the number of profitable projects $\{j(R^E)\cdot(X-1)\}$.

From E1, entrepreneur j undertake the production project if

$$R_j \geq \{1 + R^E\cdot(X - 1)\cdot(1 - P_b\cdot P_f)\} / (1 - P_b\cdot P_f)\cdot X$$

$$\partial R_j/\partial R^E \geq (X - 1)\cdot(1 - P_b\cdot P_f) / (1 - P_b\cdot P_f)\cdot X > 0$$

Thus, $\partial j/\partial R^E < 0$. In words, the number of profitable projects is a decreasing function of R^E since only a small number of projects are profitable after making large payment to savers.

The equilibrium condition is:

$$n\cdot\theta^*(R^E) = j(R^E)\cdot(X-1)$$

There exists the equilibrium return on saving R^E that satisfies this condition because this economy has a usual upward sloping supply curve and a downward sloping demand curve. If we assume that $R_j - R_{j+1} = \varepsilon$, which is a very small number, the equilibrium return is the one that satisfies the zero profit condition for the marginal entrepreneur j^*. The marginal entrepreneur j^* makes no economic profit because of the threat that entrepreneur j^*+1 bids away saving.

2.d. Financial Intermediation

Now, let's introduce another type of economic agents, banks. Bankers are risk neutral and endowed with a technology to diversify risks at no cost and Y units of goods each. These goods are identical to goods owned by other economic agents for consumption and storage purposes, but cannot be used for production.[5] Thus, their opportunity cost is 1 per unit. Under these assumptions, it is costless for risk-neutral bankers to diversify risks and assume nondiversifiable risks with their capital. If savers can observe the behavior of banks perfectly, competition for risk-averse savers will force banks to offer risk-free deposits by diversifying to the maximum extent and holding enough capital. The diversification and transfer of risks lower the equilibrium return on saving and increase aggregate investment in production.

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[5]This assumption is made to simplify the condition of the aggregate supply of funds.

In this economy, banks can completely diversify the failure risks of individual projects by lending the equal amount to all entrepreneurs undertaking investment projects. Then there remains only the risk of the state of the economy. The expected utility of savers with complete diversification becomes:

$$E(U_s) = P_b \cdot [U\{(1-\theta)+(1-P_f)\cdot\theta\cdot R^E\} + (1-P_b)\cdot U\{(1-\theta)+\theta\cdot R^E\} \qquad \text{(E3)}$$

In the bad state, a saver recovers $(1-P_f)\cdot\theta\cdot R^E$ from their investment θ because the proportion P_f of production projects fails.

$$\partial E(U_s)/\partial\theta = P_b\cdot\{\partial U(C_{LD})/\partial C_{LD}\}\cdot\{(1-P_f)\cdot R^E-1\} + (1-P_b)\cdot\{\partial U(C_H)/\partial C_H\}\cdot(R^E-1)$$

where C_{LD} denotes the amount of consumption when the low portfolio return with diversification is realized, $[(1-\theta)+(1-P_f)\cdot\theta\cdot R^E]$.

With the diversification of risks, $\partial E(U_1)/\partial\theta$ becomes higher at every level of θ for all $R^E \geq 0$.

$$[\partial E(U_s)/\partial\theta]^D - [\partial E(U_s)/\partial\theta]^{ND} = P_b\cdot\{(1-P_f)\cdot(R^E-1)\cdot\{\partial U(C_{LD})/\partial C_{LD} - \partial U(C_H)/\partial C_H\}$$
$$+ P_b\cdot P_f\cdot\{\partial U(C_L)/\partial C_L - \partial U(C_{LD})/\partial C_{LD}\} > 0$$

since $C_L < C_{LD} < C_H$ and $U_s(C_H)/\partial C_H < U_s(C_{LD})/\partial C_{LD} < U_s(C_L)/\partial C_L$

where superscripts D and ND denote the cases of diversification and no diversification.

Then θ^* is higher at every level of R^E when risks are diversified. In aggregate, the supply curve becomes flatter when investment in production involve less risks. Therefore, diversification leads to a lower R^E and a higher level of investment in production.

Banks assume nondiversifiable risks by pledging their capital in addition to diversifying risks. Banks offer a fixed return to savers and absorb losses with their capital if the bad state occurs. Bank capital K can absorb all losses in the bad state if

$$K \geq \{R^D - (1-P_f)\cdot R^E\}\cdot D$$

where R^D is the contracted return on bank deposits.

When saving becomes risk-free, the expected utility of savers is:

$$E(U_s) = U\{(1-\theta)+\theta\cdot R^D\}$$

$$\partial E(U_s)/\partial\theta = \{\partial U(C)/\partial C\}\cdot(R^D - 1)$$

Thus, $\theta = 1$ for $R^D \geq 1$. Then the competitive solutions are $\theta = 1$ and $R^D = 1$ because the supply of deposits is infinitely elastic at $R^D = 1$.

In a competitive market, banks make zero economic profit. Thus, the expected return on investment becomes equal to the expected return on deposits.

$$E(R^D) = (1-P_b\cdot P_f)\cdot R^E = E(R^E) \qquad \text{(E4)}$$

When $E(R^D) = E(R^E) = 1$, all available production projects are utilized because $E(R_m) = 1$ by A1. Thus, the diversification and transfer of risks result in a lower equilibrium return on saving and a higher level of investment.

2.e. Monitoring of banks

If depositors fail to monitor banks perfectly, banks can increase the "option value," an expected profit arising from limited liability, by diversifying less and/or reducing the capital ratio. This moral hazard problem is widely recognized {e.g., Merton (1977), Marcus (1984), and Keeley (1990)}. Depositors need to observe asset portfolios and capital ratios to monitor banks to assure the solvency of banks. For analytical convenience, let's assume that depositors observe asset portfolios accurately but observe capital ratios with noise.[6] Thus, banks diversify perfectly but attempt to reduce capital ratios.

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[6]Qualitative results are similar when depositors observe asset portfolios, instead of capital ratios, with noise or observe both variables with noise. The option value of banks arises from the possibility of negative net worth. Banks in this model can increase the expected negative worth, while preserving the expected return on assets, by diversifying less and/or holding less capital. Thus, it is sufficient to consider one of the two variables. Since the distribution of return on assets changes with the degree of diversification, the analysis becomes unnecessarily complicated when the degree of diversification is allowed to vary.

The expected profit of a bank is:

$$E(\pi) = \begin{cases} P_b \cdot \{(1-P_f)\cdot R^E - R^D\}\cdot D + (1-P_b)\cdot(R^E-R^D)\cdot D & \text{if } K \geq \{R^D-(1-P_f)\cdot R^E\}\cdot D \\ P_b\cdot(-K) + (1-P_b)\cdot(R^E-R^D)\cdot D & \text{if } K < \{R^D-(1-P_f)\cdot R^E\}\cdot D \end{cases} \quad \text{(E5)}$$

When $E(R^D)$ is perceived to be R^D, $R^D = (1-P_b\cdot P_f)\cdot R^E$ from E4. Substituting $(1-P_b\cdot P_f)/R^D$ for R^E,

$$E(\pi) = \begin{cases} 0 & \text{if } K \geq \{R^D-(1-P_f)\cdot R^E\}\cdot D \\ (1-\alpha)\cdot P_b\cdot\{1 - (1-P_f)\cdot(1-P_b\cdot P_f)\}\cdot R^D\cdot D > 0 & \text{if } K < \{R^D-(1-P_f)\cdot R^E\}\cdot D \end{cases} \quad \text{(E6)}$$

where $\alpha = K/[\{R^D-(1-P_f)\cdot R^E\}\cdot D]$

$$\partial E(\pi)/\partial K = -P_b\cdot\{1 - (1-P_f)\cdot(1-P_b\cdot P_f)\}\cdot R^D\cdot D \;/\; [\{R^D-(1-P_f)\cdot R^E\}\cdot D]$$

$$\text{for } K < \{R^D-(1-P_f)\cdot R^E\}\cdot D$$

Thus, once capital falls below $\{R^D-(1-P_f)\cdot R^E\}\cdot D$, reducing capital increases the expected profit.

A large number of banks compete for deposits. Initially, every bank pledges Y units of goods as capital. After taking deposits, banks can adjust, i.e., lower, their capital ratios. Depositors infer whether or not a bank lowered its capital ratio below the one required to pay off depositors in the bad state from a noisy indicator. Depositors move their funds from banks judged to have lowered their capital ratios (risky banks) to banks perceived to have enough capital (safe banks). This selection process, banks' selection of capital ratios and depositors' selection of banks, is completed before banks lend to entrepreneurs. This assumption is made to avoid the analysis of bank runs and liquidation costs, which are not focuses of this paper. The probability that a bank is perceived to be risky is a decreasing function of the ratio of capital to deposits. Banks maximize the expected profit by selecting the optimal capital ratio. From E6,

$$E(\pi) = P_r\cdot 0 + (1-P_r)\cdot(1-\alpha)\cdot P_b\cdot\{1 - (1-P_f)\cdot(1-P_b\cdot P_f)\}\cdot R^D\cdot D \quad \text{(E7)}$$

where P_r = the probability that a bank is perceived to be risky. Since α is a multiple of the capital ratio, P_r is a function of α.

If a bank is perceived risky, the profit is zero because it is forced out of business. When it is perceived safe by depositors, the expected profit is the option value.

$$\partial E(\pi)/\partial K = \{-(\partial P_r/\partial\alpha)\cdot(1-\alpha) - (1-P_r)\}\cdot(\partial\alpha/\partial K)\cdot P_b\cdot\{1 - (1-P_f)\cdot(1-P_b\cdot P_f)\}\cdot R^D\cdot D$$

The profit maximizing condition is:

$$-(\partial P_r/\partial\alpha) = (1-P_r)/(1-\alpha)$$

Let the probability be a simple function of α:

$$P_r = \begin{cases} \beta\cdot(1-\alpha) & \text{if } \beta \leq 1/(1-\alpha) \\ 1 & \text{if } \beta > 1/(1-\alpha) \end{cases}$$

where β is a positive constant determined by the quality of information available to depositors. The quality of information, β, is known to depositors.

In this case, the profit maximizing condition is:

$$\alpha = \begin{cases} 0 & \text{if } \beta < 1/2 \\ (2\beta-1)/2\beta & \text{if } \beta \geq 1/2 \end{cases}$$

The optimum α increases with β. Thus, a larger value of β indicate that depositors have more accurate information and, hence, better monitoring ability of depositors.

Depositors, who are rational, take this maximizing behavior into their consideration. When α is less than 1, the return on deposits is less than R^D in the bad state. Then a deposit contract offering $R^D = 1$ is not acceptable to depositors. In this situation, it is necessary for banks to raise the lending rate. Although banks can increase the contracted rate of return on deposits by passing on their increased profits to depositors, the increase is not sufficient to compensate risk-averse depositors. When $E(R^E) = 1$, the combined expected return to banks and depositors is 1. Thus, if banks set R^D ($R^D > 1$) such that their expected profits are zero, $E(R^D)$ is 1. When $\alpha < 1$, the variance of return on deposits is positive because depositors do not fully recover their principal in the bad state. A contract offering zero expected rate of return and a positive variance is not acceptable to risk-averse depositors. Therefore, imperfect monitoring requires higher lending rates.

When savers estimate a positive probability of bank failure ($\alpha < 1$), their maximization problem is similar to the case without the transfer of risks.

$$E(U_s) = P_b \cdot U\{(1-\theta)+\theta \cdot Z\} + (1 - P_b) \cdot U\{(1-\theta)+\theta \cdot R^D\} \tag{E8}$$

where $Z = (1-P_f) \cdot R^E + \alpha \cdot \{R^D - (1-P_f) \cdot R^E\}$, the estimated amount to be recovered per unit of deposits in the bad state ($Z < 1$).

As shown above, the maximization of this expected utility with respect to θ will produce an upward sloping supply curve of deposits. Then banks can find R^D [$R^D = E(R^E) > 1$] at which demand equals supply. At this new equilibrium with monitoring problems, both depositors and bankers are better off at the expense of entrepreneurs. Depositors benefit from higher return on saving, and bankers enjoy a positive option value. Imperfect monitoring, however, results in a deadweight loss. Higher equilibrium return on saving lowers the level of investment and, hence, production.

More serious monitoring problems (lower β) and attempts to increase the option value (lower α) will induce depositors to perceive higher risk of deposits, which is characterized by a smaller Z. Differentiating E8 with respect to θ,

$$\partial E(U_s)/\partial\theta = P_b \cdot \{\partial U(C_f)/\partial C_f\} \cdot (Z - 1) + (1 - P_b) \cdot \{\partial U(C_s)/\partial C_s\} \cdot (R^D - 1)$$

$$\{\partial E(U_s)/\partial\theta\}/\partial Z = P_b \cdot \{\partial U(C_f)/\partial C_f\} > 0$$

where $C_f = \{(1-\theta)+\theta \cdot Z\}$, the amount of consumption if the bank fails

$C_s = \{(1-\theta)+\theta\cdot R^D\}$, the amount of consumption if the bank survives.

Thus, holding R^D constant, θ^* is smaller when the deposit contract is riskier because $\partial E(U_s)/\partial\theta$ is lower at every level of θ. Then the supply curve of saving becomes steeper. The results are a higher equilibrium return on saving and a lower level of investment. With a higher risk of deposits, the surpluses to depositors and bankers depend on the elasticity of demand. In sum, monitoring problems reduce the effectiveness of financial intermediation in this economy.

2.f. Deposit Insurance

In this economy, deposit insurance backed by the government can improve social welfare. The government can completely eliminate risks for depositors if there are enough resources to pay off depositors in the bad state. Algebraically,

$$\sum_{j=(1-P_f)\cdot m}^{m} R_j\cdot X \geq n$$

In the bad state, $P_f\cdot m$ investment projects fail. The worst outcome is that failed projects are the most productive ones. If the return from investment in the worst case is greater than or equal to the endowment of risk-averse individuals, transfer through taxation can guarantee the endowment of savers. Thus, deposit insurance can transfer all risks from depositors to entrepreneurs. If the above condition is not met, deposit insurance will reduce risks, instead of eliminating them. In any case, risks for depositors will be minimized when deposit insurance is provided by the government, which faces least resource constraints.

With deposit insurance that makes deposits risk-free, the supply of funds becomes perfectly elastic at the return on saving of 1. Then expected output is maximized because all investment opportunities are utilized. All economic agents benefit from the increase in expected output if an appropriate redistribution scheme is provided. The government can tax those economic agents who realized positive return to redistribute income as well as pay off depositors of failed banks. The tax may be levied such that it does not affect the expected return and, hence, the investment decision of the marginal entrepreneur.

The expected amount of consumption is the sole determinant of the expected utility of risk-neutral entrepreneurs. Ignoring taxes for a moment, deposit insurance increases the expected consumption of entrepreneurs by lowering borrowing costs for entrepreneurs already in business and enabling more entrepreneurs to undertake investment. The expected gain in the aggregate consumption of entrepreneurs with insurance is:

$$E(G_E) = m_1 \cdot (1-P_b \cdot P_f) \cdot (R^{EN}-1) \cdot (X-1) + \sum_{j=m_1+1}^{m} \{E(R_j)-1\} \cdot X$$

where R^{EN} = equilibrium borrowing cost with no deposit insurance

m_1 = number of profitable projects at $R^E = R^{EN}$.

The first term of the above equation, which is the gain from lower borrowing cost, is a transfer from depositors and bankers to entrepreneurs. The second term is the increase in production.

To make depositors equally well off, the government does not need to compensate depositors with the same expected amount that depositors would consume without insurance to make them equally well off. Since depositors are risk averse, the certainty equivalent income is smaller than the expected income. In other words, depositors can be satisfied with a smaller expected amount of consumption if the government eliminates risks for them. Algebraically, the transfer to depositors to make them as well off:

$$TR^D < m_1 \cdot (1-P_b \cdot P_f) \cdot (R^{EN}-1) \cdot (X-1) - E(\Pi^N)$$

where Π^N is the aggregate profit of banks with no deposit insurance.

Thus, holding the surplus of bankers constant, the redistribution can make both savers and entrepreneurs strictly better off.

With deposit insurance, depositors do not monitor banks. If the government is not as effective as depositors in monitoring banks, a larger portion of entrepreneurs' income will be transferred to bankers in the form of higher taxes. In this model, inferior monitoring ability means a smaller value of β. The change in the expected profit of banks is:

$$\begin{aligned} E(\pi^I) - E(\pi^N) &= \{1-\alpha(\beta^I)\}\cdot P_b\cdot\{1 - (1-P_f)\cdot(1-P_b\cdot P_f)\}\cdot R^{DI}\cdot D^I \\ &\quad - \{1-\alpha(\beta^N)\}\cdot P_b\cdot\{1 - (1-P_f)\cdot(1-P_b\cdot P_f)\}\cdot R^{DN}\cdot D^N \\ &= \{\alpha(\beta^N)-\alpha(\beta^I)\}\cdot P_b\cdot\{1 - (1-P_f)\cdot(1-P_b\cdot P_f)\}\cdot R^{DN}\cdot D^N \\ &\quad + \{1-\alpha(\beta^I)\}\cdot P_b\cdot\{1 - (1-P_f)\cdot(1-P_b\cdot P_f)\}\cdot(R^{DI}\cdot D^I - R^{DN}\cdot D^N) \end{aligned}$$

where superscripts I and N denote cases of insurance and no insurance.

If $\beta^I < \beta^N$, $\alpha(\beta^I) < \alpha(\beta^N)$. Thus, banks increase their expected profits by holding less capital when the government is inferior to depositors in monitoring banks. Assuming for simplicity that entrepreneurs bear all tax burdens, the bankers' gain is the entrepreneurs' loss. However, as long as the increased tax burden does not exceed the gains from lower borrowing costs and increased investment [$(E(G_E) \geq TR^D + E(\pi^I)$], entrepreneurs are better off with deposit insurance. Even if entrepreneurs are worse off due to a substantially inferior ability of the government to monitor banks, the income transfer among risk-neutral agents may not significantly affect aggregate utility.

In this model, imperfect monitoring by depositors lowers production, while imperfect monitoring by the government simply results in income transfer from entrepreneurs to bankers. Thus, social welfare clearly improves with the government provision of deposit insurance. Social welfare can deteriorate if banks invest in negative net-present-value projects, as well as profitable ones, to increase the variance of asset returns. Even in that case, welfare may still improve unless deposit insurance increases investment in more negative than positive net-present-value projects, that is, unless the government is an extremely ineffective monitor. Therefore, it is not necessary that the government monitor banks as effectively as depositors to improve *ex ante* social welfare.

3. Conclusion

This paper has shown that the transfer of nondiversifiable risks from risk-averse savers to other risk-neutral agents increases aggregate investment. The transfer of risk requires debt contracts offering fixed rates of return and pledge of capital by financial intermediaries. These conditions are not sufficient to transfer risk completely if monitoring of financial intermediaries is less than perfect. A solution to monitoring problems is deposit insurance backed by the government. Imperfect monitoring by the government mainly results in income transfer rather than lower production. Thus, deposit insurance can improve welfare even if the monitoring ability of the government is somewhat inferior to that of depositors.

The above argument suggests a unique value of traditional banks that offer deposits backed by the government and make risky loans. Although other financial institutions successfully perform many traditional functions of banks such as liquidity provision, information production, and diversification of risks, they do not effectively transfer nondiversifiable risks from risk-averse agents to risk-neutral ones. Thus, assuming that the economy is composed of individuals with different attitudes toward risk, other intermediaries may not fully satisfy the needs of highly risk-averse agents. In this regard, banks and deposit insurance make a unique contribution to economic well-being.

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